Formation of Nano-crystals on the Surface of Glass Fibers

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Formation of Nano-crystals on the Surface of Glass Fibers

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ABSTRACT

In this presentation I describe how to create nano-structured crystalline layer on the surface of micron glass fibers, and how to control the concentration profile of the layer. The glass fibers studied here are made from an iron aluminosilicate system. I demonstrate how significantly the resulting layer enhances the high temperature stability of those fibers acting as fire-safe insulation materials. To obtain the nano-layer, systematic heat-treatments on the fibers are carried out under atmospheric conditions near the glass transition temperature for different durations. The oxidation process leads to oxidation of ferrous to ferric ions, and thereby to migration of Ca^{2+}, Mg^{2+} and Fe^{3+} ions from the interior to the surface of the fibers. It is found that the diffusion of the Mg^{2+} ions is predominant in the overall cationic diffusion. The Mg^{2+} ions react with oxygen on the fiber surface, and consequently a nanocrystalline MgO layer forms, which is identified using the X-ray diffraction (XRD) and Secondary Neutral Mass Spectroscopy (SNMS). The MgO is the main crystalline phase of the nano-layer, whereas the interior of the fibers remains amorphous after oxidation. The dependence of the thickness of nanocrystalline layer on the duration of heat-treatment is illustrated. Based on this dependence the kinetics of diffusion can be established. The MgO layer is removable in an acidic aqueous medium under certain conditions. Finally, I briefly show how to generate the inward diffusion of cations, and its consequences to structure of the fiber surface.